CHAPTER 5

Near-death Experiences and Ecstasy: a Product of the Organization of the Human Brain?

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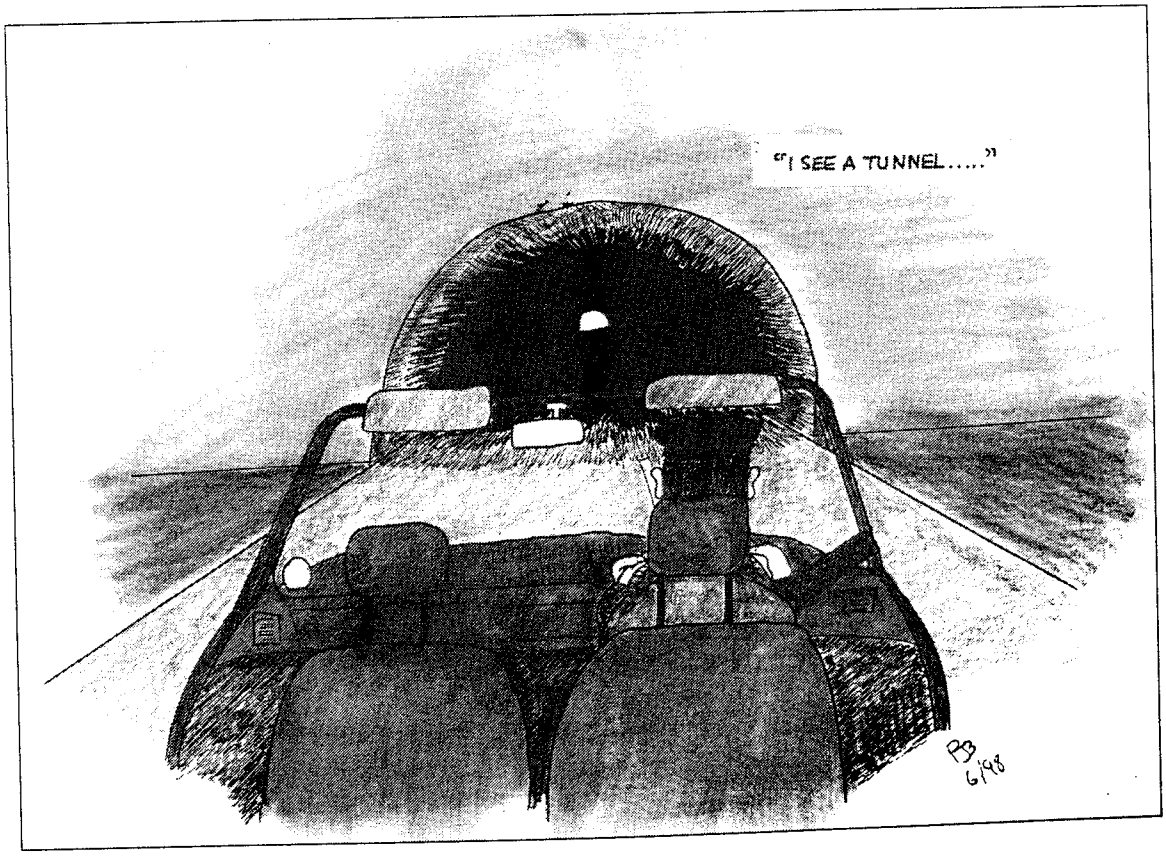

INTRODUCTION

The belief that the mind, a term wide enough to embrace both "sense of self" and "soul", maintains temporal continuity before and after the organic deterioration of the brain has been one of the most persistent in human history. The idea of a continuum between the mind and a cultural god or afterlife reduces the anxiety created by the anticipated dissolution of the self, hence reinforcing the saliency of this belief (Persinger, 1985). The personal accounts of those who have had a near-death experience (NDE) influence and reflect the nature (and details) of this belief.

DEFINITION OF NDE

NDE is a general label applied to the remembrance of subjective phenomena that occur when the person approaches neurophysiological limits after which death is highly probable. Although the general similarity of NDEs through human time and across human culture would be expected if the human mind existed as an independent entity, their common themes may emerge from a factor that has until recently eluded the purely egocentric references of personal experience. The similarities across various NDEs are also predictable because the gross structural patterns and neuroelectrical configurations of the billions of brains that define the continuum of our species were and still remain more congruent than discrepant (Persinger, 1987). The fact that similar dosages of hundreds of different pharmacological compounds can evoke very specific experiences in people cross-culturally and through time emphasizes the strength of this similarity.

PHENOMENOLOGICAL PATTERNS OF NDEs

That a person remembers a NDE indicates that the portions of the mesiobasal temporal lobes, specifically the hippocampus and amygdala (Figure 5.1), were functioning within normal limits. If the consequences of the trauma that generated the NDE were too extreme and the optimal patterns of hippocampal activity were exceeded, only dense amnesia would remain; there would be no representation of experience. NDEs should be more probable when the physiological boundaries of brain integrity are approached but not penetrated (Persinger, 1974).

There are multiple subtypes of human memory, each of which maximally involves statistically greater activity within different regions of the brain (Grafton, 1995; Ungerleider, 1995). Reports of NDEs require autobiographical memory (Fink et al., 1996), aspects of episodic memory, and autonoetic awareness (Wheeler, Stuss and Tulving, 1997). The "memory" of one's self in time and space is a reconstructional process involving arrangements (strongly influenced by contextual cues) and integrations of the neural representations of the past experiences mediated through words. Consequently, the report of an experience emphasizes the strong contribution of language and cultural expectations to this reconstructed "memory". The specific beliefs, in large part derived from the person's culture and reinforcement history, will be reflected in the details of the NDE.

For example, one of my patients who sustained a trauma to his right parietal lobe during a snowmobile accident reported his experience as follows:

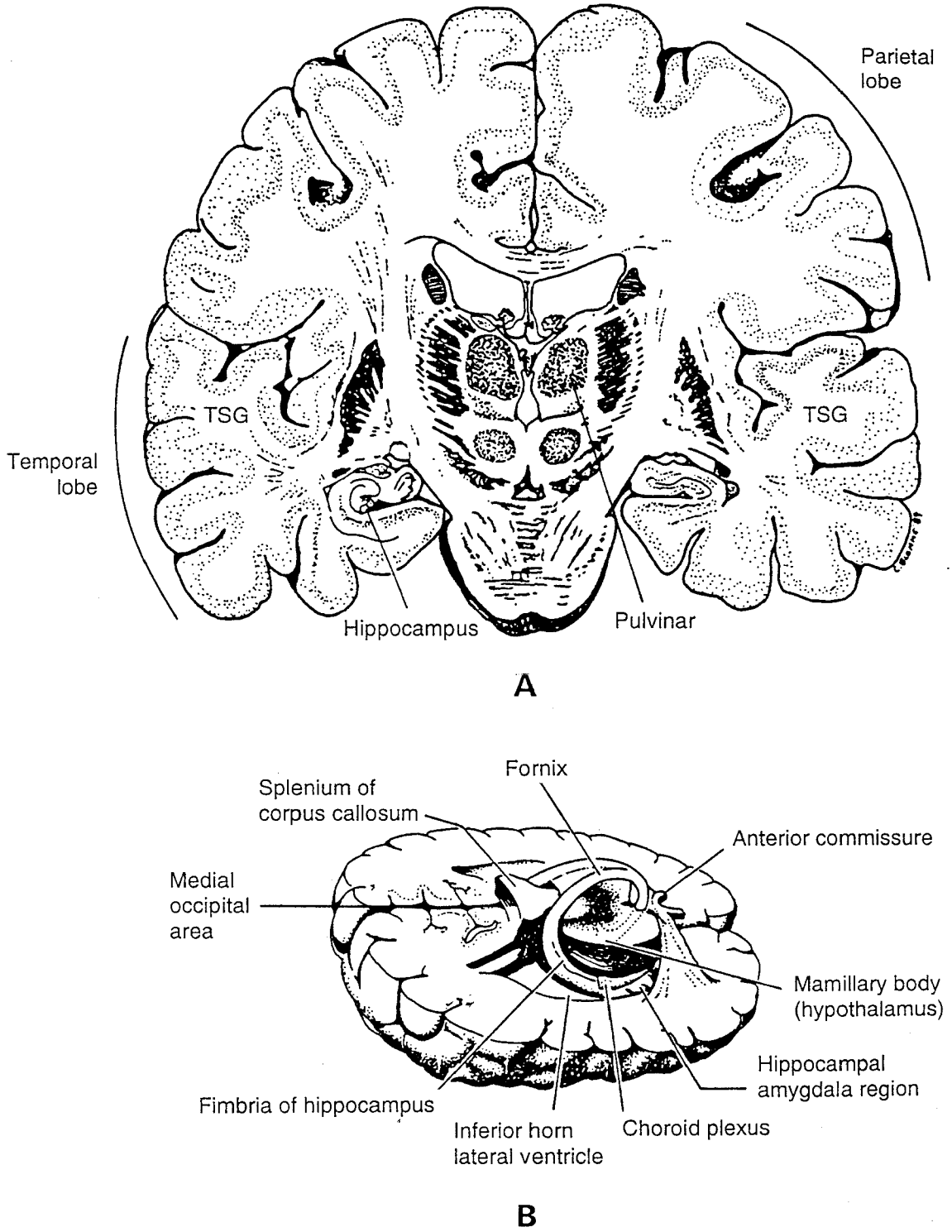

Figure 5.1 Diagram of human brain. (A) Coronal section (a cut from left to right across the cerebrum) showing the key structures. TSG refers to temporal superior gyrus. (B) Horizontal orientation (partial three-dimensional perspective from back, medial occipital area, to front).

I was suddenly sitting in the backseat of a white limousine travelling down a narrow road . . . everything was white around me . . . a kind of bright, blinding glowing light. I could see the back of the driver's head but I could not see his face. I could feel us moving forward through this narrow street . . . I could not see anything from the side windows, just movement up ahead. A red stop light suddenly appeared and the car stopped. The door opened and I

figured I should get out when my grandmother poked in her head and said "you stay put, it's not your time". The next thing I recall I was in the hospital.

This patient was employed as a car mechanic and parts specialist; the grandmother, for whom he felt strong emotional bonds, had died about 6 months before and was his strongest association with personal death.

NEUROPROCESSES AND NEUROMECHANISMS INVOLVED IN NDE

At any given time those portions of the brain that are most metabolically active will determine experience. The basic themes of the NDE are consistent with the transiently electrical enhancement within aggregates of neurons from which the experiences are generated (Blackmore, 1993). Most of these neurons (Figure 5.1) are located within: (1) the medial portions of the occipital surface (with input from a deep brain nucleus called pulvinar) which contain the representations from the peripheral or perimacular visual fields from the retina; (2) the superior parietal lobes; (3) the medial and ventral portions of the temporal cortices that are associated with representations of human faces, colours and some vestibular inputs; and (4) the hippocampal–amygdaloid structures, which are supposed to be the gateway for the consolidation of autobiographical episodic memories and their "meaning" or emotional significance.

The blood supply (the primary source of oxygen and glucose) to most of these regions is provided by branches and sub-branches (spriglets) of the posterior cerebral arteries (PCAs). They are derived from the vertebral–basilar arteries, one of the two major arterial inputs into the brain. There is an artery for the left cerebral hemisphere and an artery for the right cerebral hemisphere. One would expect that even small discrepancies between the bloodflow in one of the two hemispheres, particularly the right because of its statistically greater flow rates, would dominate the general theme (spatial movement and experiences involving spatial referents) of the NDE. Ischaemia within some branches of the PCA can be produced even by some forms of heart dysfunction and can be influenced by gender or genetic factors (Bogousslavsky and Caplan, 1993).

Mechanical impacts to the skull or vascular insufficiency (from cardiovascular failure) frequently disrupt the normal function of the PCAs, and therefore these two conditions commonly precede NDEs. Inhibitory interneurons, the most numerous subtype of neurons within the cerebral cortex and limbic system, are particularly vulnerable to hypoxia, and interference with them would release the experiences processed by adjacent structures into awareness. As long as the electrical activity within the hippocampal formation can hold the representation of the experience until more permanent consolidation occurs, the experience can be "remembered".

Other stimuli could trigger activity within this neuronal matrix, without any requirement for the subject to be actually "near" physical death. They include: (1) metabolic hypoxia (due to starvation, insulin surges or even high altitude), which could selectively interfere with hippocampal activity; (2) specific surgical anaesthetics whose mechanisms involve reduction of consciousness by partial hypoxia; (3) ingestion of α_2 receptor agonists such as ketamine or some hallucinogens that can directly affect neurons or produce vasospasm within the blood vessels that supply those neurons; (4) patterns of applied electromagnetic fields whose complex sequences are resonant with the groups of limbic neurons

activated by partial hypoxia; and (5) rituals that induce hypoxia, hypoglycaemia (starvation) or the release of endogenous opiates (nociceptive inputs or meditation).

The specific serial activation of these neuronal aggregates is thought to be the substrate for the temporal evolution of the personal NDE. Since metabolic changes brought about by a trauma often follow very similar sequences in the brain, the "unfolding" of the "average" NDE should be similar.

Under extreme oxygen failures, brain tissues surrounding the structures supplied by the PCA would be activated because they would be disinhibited by the marked reduction of neural input. The most frequent regions within this toroidal or penumbral field are the amygdala and hippocampus (Figure 5.1), portions of the nucleus accumbens, and cortical regions of the parietal lobes and the superior gyrus of the temporal lobes that mediate the body image and vestibular-visual sensations, respectively. Because the posterior choroidal arteries, which are derived from the PCA (and supply the portions of the midbrain associated with vision and hearing), interface and fuse with the anterior choroidal arteries (which supply the hippocampus and amygdala), vascular steal or shunting of blood from the anterior to the posterior system would induce a relative hypoxia within the hippocampal regions.

However, depending upon the region of transient hyperactivity, the NDE can be fragmented and very modality-specific. The experience would not reflect the progression of successive disinhibition of groups of neurons with different thresholds. A fragmented NDE would involve only one component of the potential theme of what would have been experienced had hypoxia emerged more slowly. For example, a 40-year-old bilingual left-handed man drank too much alcohol before driving his snowmobile. He struck an ice-break, was thrown from the machine, and hit his head on an outcrop of rocks; consciousness was suspended. As he awoke, he heard a voice say "stop drinking liquor you asshole". After this episode he gave up drinking and displayed an aversion to the smell and taste of ethanol.

A COMMON COURSE OF EXPERIENCES IN NDE

The first stage following a brain injury, induced by impact from mechanical energies (the most common cause), microvascular failure or alterations in ligand (neurotransmitter) binding, would be vestibular experiences that include vibrations, spinning, dizziness, displacement in space or "pulling by a force". For example, a 21-year-old woman who sustained a right parietal lobe trauma (and subsequent electrical activation of the anterior right insular orbitofrontal region) remembered her "self" suddenly looking down upon her body that was connected to a heart monitor. She did not feel as if she were floating but experienced a type of "constant vibration".

Depending upon the type of precipitating stimuli, the feeling of blissfulness occurs differentially over the duration of the NDE. Sudden mechanical impacts or vascular failures sufficient to produce immediate "falling" (hypotonia of the lower limbs) but maintenance of consciousness (a classic indicator of disruption in PCA circulation) could induce the release of the endogenous opiates and the activation of the amygdaloid neurons dominated by the subtype of receptors with which the experiences of euphoria and blissfulness are associated. Because the amygdala is associated with the meaningfulness of experiences, its optimal activation could also generate the feeling of profundity.

Additional mild disruption of bloodflow and enhanced electrical activity of neurons in the caudal structures within the thalamus or within the periaqueductal grey of the midbrain could also elicit experiences of pleasantness with characteristics of analgesia, lightness and floating.

A more pronounced hypoxia (such as drowning), which would preferentially affect the hippocampal formations (due to the unusual geometry of the blood supply and its specific neurochemistry), would increase the probability of disinhibition within these structures. The person would be inundated with images from his or her experiential repertoire; this sequence of firing would represent the "life review". The concomitant disruption of the mediodorsal thalamus or its major input from the amygdala would be associated with a marked distortion of subjective time. One's whole life could be "felt" to have occurred instantaneously.

As the neurons within the medial occipital cortices are activated transiently by insufficient blood supply (and then released from inhibition) and inhibitory interneurons begin to fail, the peripheral portion of the visual field becomes activated and the contrast between the central portion of the visual field (whose cortical neurons are supplied by spriglets of the middle cerebral artery) and the peripheral field is enhanced. The experience of a tunnel emerges. With the concomitant activation of neurons within the superior temporal lobe that subserve the experience of radial gradients (Duffy and Wurtz, 1997), the person experiences vestibular movement through the gradient which can be described as a "tunnel", "light shaft", "narrow valley", "vortex" or even "highway" or "road".

The "bright" light, which is not (and should not be) reported in all NDEs, would be an expected correlate of activation of the pulvinar or its connections with the occipital cortex. This association nucleus within the thalamus is differentially supplied by a spriglet of the PCA. The stronger foveal connections between the pulvinar and the occipital pole associated with the central field would contribute to the experience of a bright circular light at the end of the tube or tunnel.

However, NDEs also display themes which are clearly neocortical and involve language and experience. People who have had an NDE report various themes of the "sensed presence" which is later attributed to a dead relative, spirit, alien, or god. For example, the 21-year-old woman mentioned above, who reported herself "vibrating over her body" (but did not experience a tunnel), also stated that she "felt the presence of God" and she "knew that he was bigger, more powerful and more expansive than anyone had imagined".

OUT-OF-BODY EXPERIENCE

The occurrences of both detachment of the self and dreamy states with concomitant awareness of "another consciousness", regardless of the attribution to a spirit, god or "second self", are relatively frequent during spontaneous ictal periods for patients who display complex partial seizures with a limbic focus (Bancaud et al., 1994). Very similar experiences, described as identical to the "natural" experiences by the patients, can also be surgically induced by electrical stimulations that encourage interactions between the lateral temporal cortex, the hippocampal formation and the amygdala (Gloor et al., 1982, 1993). In fact every component of the themes of NDE – from the tunnel experience to blissfulness – has been reproduced or elicited by electrical stimulation of the epileptic brain.

Within the context of the NDE, the detachment is described as an out-of-body experience (OOBE). Although OOBEs can occur in the absence of a classical NDE or without obvious insult to the brain or body, the thematic pattern of the experiences is similar. The primary difference between OOBEs not associated or associated with NDEs is the emphasis within the latter upon death themes, inferences concerning non-dissolution of the self (immortality) and religious innuendo. During the one or two seconds of realization of imminent death, the continued activation of the left prefrontal cortex, lateral temporal cortices, hippocampal formation and amygdala would encode experiences according to the experient's *current* cognitive context (i.e. near-death).

As long as these experiences are maintained within the deep portions of the temporal and parietal lobes (the extrastriate regions), in a manner similar to dreams, they would be available for later reconstruction (within a few seconds) by the right prefrontal cortex when the person "regained consciousness". As in dreams, the decreased activation of the primary visual regions and the prefrontal areas during this transient state would suffuse the experiences generated *within* the person's brain with powerful emotions. Without the reality check carried out by prefrontal operations during this suffusion, the experiences would appear as real as waking sensations and would be accepted without challenge.

The feeling of a sense of self independent of the body is possibly the primary phenomenological basis for the belief in mind–body dualism. During dream states, normal human beings can "see" themselves from "outside" of their body as well as be aware of this observation from "within" their body. There is some evidence suggesting that the capacity to detach and to experience the sensed presence is essentially determined by the existence of mild variations in the microstructure and neuroelectrical coding of experience within the left and right cerebral hemispheres.

Recently I have proposed a hypothesis based on the above-mentioned hemispheric imbalance, which I called vectorial hemisphericity (Persinger, 1993a). According to this hypothesis, the sense of self is fundamentally a linguistic process (which should be experimentally accessible by the appropriate neuroelectromagnetic patterns) with a slight but statistically greater representation within the left hemisphere. A right-hemisphere homologue to the left hemisphere sense of self was also postulated. When this right-hemisphere homologue is stimulated and the resultant electrical patterns intrude into left-hemispheric awareness, the person will experience the sensed presence (Cook and Persinger, 1997) which, depending upon the concomitant limbic affect of unpleasant or pleasant, is attributed to demons or to gods, respectively. However, when the integrity of the left-hemisphere activity is preserved and is represented together with its right-hemisphere homologue, the sense of self is maintained but the experience of being detached or out of the body will be reported.

Although we have supported this hypothesis with experimental data and the general trend is replicable experimentally, there are still confounding variables, such as the specific modulatory role played by different regions within the right prefrontal cortex. They influence the "format" or the linguistic structure by which the neuroelectrical patterns, maintained during altered states of consciousness, are organized. At present, our experimental results are consistent with the interpretation that relative activation of left-hemisphere processes in conjunction with right-hemisphere deactivation, following a brief period of marked vigilance (right-hemisphere activation), increases the probability of an OOBE. As the right-hemisphere activity compensates and the person's physiological status returns to normal, the sense of a presence and the auditory experiences are more

likely to be reported. Within the classic NDE the sensed presence is enhanced towards the end of the sequence and is often associated with a short auditory sequence, which is interpreted by the experient as "a message", "an instruction", or "special information". As normal neuroelectrical interaction and the required reciprocal inhibition between the left and right hemisphere returns, the subjective experience is a "return to the body" (Persinger, 1995).

FREQUENT QUESTIONS ABOUT NDE

Are NDEs Always Reported to be Pleasant?

Considering the likely neural substrates of NDEs, they will always be personally profound and meaningful. However, they will not always be pleasant. About 7% of people who reported NDEs (Persinger, 1974) before the contemporary enthusiasm to report only the more positive components of these natural phenomena (Eadie, 1992) stated that their mood was negative, aversive or hellish. The details were congruent with the mood.

If one considers the functional organization of the amygdala, this proportion would be expected. In fact, the amygdala and related neural groups that mediate reward and punishment are organized intrastructurally with areas of subjectively pleasant experiences (ecstasy to orgasm) surrounded by inhibitory areas of negative or unpleasant experiences. As shown in several mammalian species, including humans (Grossman, 1967), small electrical currents induced within limbic regions of the brain are associated with positive experiences as defined by approach behaviour. However, as the amplitude of these electrical currents increases and their consequences (recruitment of larger and larger populations of neurons) spread through the surrounding inhibitory areas, negative experiences emerge; this is inferred from the observed avoidance behaviour in non-human animals and marked "fear" or "affective painfulness' in humans.

If the electrical lability of the neurons begins to approach the values sufficient to generate negative experiences, then disruptions or distortions of memory consolidation within the hippocampal–amygdaloid formations are also likely. Consequently, the small percentage of people (7%) that report the experiences of hellish NDEs would have been at the borderline of having *not* recalled any experiences because their existence within fragile neuroelectrical patterns and their representation within hippocampal activity would have been disrupted.

Why do Young Children Experience NDEs?

The essential themes of NDEs for young children do not differ appreciably from those of adults. However, the structures that mediate NDEs are functionally organized by the time language is sufficient to communicate with adults. The neuroelectrical integrity of the left hemisphere, more associated with language than the right in most human beings, asymptotes by age 5, while the same activity in the right hemisphere asymptotes by age 10. Autonoetic memory has clearly emerged by 4 years of age (Wheeler, Stuss and Tulving, 1997). Consequently, the argument that the "innocence" of the young brain supports the purity of the NDE is not valid because the metabolic activity and primary function of these structures are comparable in children and adults. Because many of the children whose

NDEs have been investigated were also dying, the subtle yet powerful contribution from the beliefs and incidental comments from parents and medical personnel to the specific details of the child's NDE cannot be overemphasized.

Why do People "Change" After an NDE?

The change in behaviour, often attributed to a "different" personality, after an NDE has been considered a positive consequence of the phenomenon. The reduction in anxiety concerning personal death would be expected if the experient infers that the NDE was real and therefore concludes that "there is something beyond death" or "the self exists independently of the body". Considering the importance of death anxiety to the sense of self, any profound experience – real or not – that reduces anxiety would shift the polarity of future perspectives from negative to positive.

However, many of the stimuli that initiate the NDE sequence also evoke excitotoxic death within some neurons. About 50% of all cerebral neurons survive at the hypoxic threshold. Small microinfarcts or periods of hypoxia can produce immediate necrosis or prompt apoptosis (programmed cell death). The loss of a small percentage of neurons within most structures would not be discernible by objective examination or subjective experience for most normal, healthy people because of the marked redundancy of neurons within neuromatrices associated with any given behaviour or experience. For example, at least 50% of the neurons in the portion of the midbrain that modulates motor movement must be lost before overt symptoms of Parkinsonism become obvious.

The loss of a small number of neurons, particularly within the hippocampus, would promote neuroplasticity and activate synaptogenesis (Houser, 1992). New connections would be made between neurons which were typically not associated. If we accept the dogma that structure dictates function, it becomes clear why these individuals may display different experiences and appear as different people. They may also perceive relationships between environmental stimuli that would elude the normal brain or their own brain before the event. The moderate likelihood of neuroelectrical kindling and the evoked and progressive alternation in synaptic organization due to this intermittent paroxysmal activity would encourage a gradual "evolution" of the "different person" for decades.

One characteristic that frequently emerges from the same biochemical insult that produces the NDE is temporal lobe lability or limbic sensitivity as inferred from an inventory designed to quantify the epileptic spectrum disorder (Roberts et al., 1992). Individuals who display this profile are normal people with no psychiatric symptoms who excel in the fields of music, art, poetry, creative writing and creative science. These individuals are more likely to employ intuition to solve problems and to report that they have, for example: (1) heard someone call their names before falling asleep; (2) become aware of intense smells from nowhere; and (3) become aware of the sense of the presence of a cosmic consciousness. Many of these normal individuals have sustained mild brain traumas or periods of hypoxia whose consequences would have escaped a neurological examination.

About 10% of head injury patients (mostly motor vehicle incidents) referred to us for clinical neuropsychological assessment, report a NDE. After mild brain injuries associated with NDEs, these individuals are more likely to report more psi or parapsychological experiences. Belief in parapsychological phenomena often increases and may become a secular replacement for traditional religious attributions. The widened affect experienced

by these people often allows association between stimuli, especially odd or novel stimuli, that others would consider non-consequential.

This clinical subgroup, as well as many other clinical groups who have sustained mild trauma that is followed by an enhancement of subjective experiences that suggests elevated limbic activity, are also more likely to become deeply "philosophical" (or religious) and to feel as if they have been selected personally to proselytize about their beliefs or experiences (Bear, 1979). The profile is similar to, although less intense than, that shown by patients who ultimately develop a clinically diagnosable form of limbic epilepsy or complex partial epilepsy with a focus within the temporal lobes (Persinger and Makarec, 1993).

Does Paranormal Validity Confirm the Literal Interpretation of the NDE?

There are some empirical and experimental data suggesting that remote viewing or psi experiences regarding events with strong affective components can be discerned through mechanisms not known to date. The most frequent experiments that produce weak but replicable effects involve conditions such as dream (Ullman, Krippner and Vaughn, 1989) and other stimulus procedures that encourage temporal lobe lability and input from right-hemispheric patterns (Puthoff and Targ, 1976). Cognitive styles, particularly those linked with persistent experiences associated with temporal lobe and limbic activity, increase the probability of accuracy (Bem and Honorton, 1994; Radin, 1997).

During many NDEs the experient feels as if he or she is detached from the body and in another place or dimension (Table 5.1). Information about distant events or people or events that may later occur can be "experienced". During experiments associated with OOBE, the person may actually visualize detachment and detection of target stimuli such as a series of numbers hidden on the top of a high shelf. However, the experience of the accurate detection of the target stimuli is not necessarily valid or logical. The same neurocognitive process that produced the experience (and by definition illusion) of "leaving the body" would be the one that resulted in the acquisition of the information. The conclusion that the OOBE was the cause of obtaining the accurate information would be analogous to concluding that precise information about the time of day obtained by the angles of the shadows from a sundial was due to the sun rotating around the earth. Details can be correct while their attribution or explanation is incorrect.

EXPERIMENTAL SIMULATION OF NDEs

A theory is not very fruitful unless it can generate hypotheses which allow us to devise methods and measurements that are internally consistent and can systematically and accurately predict a given phenomenon. During the last 15 years we have been discerning the effects of transcerebral application of weak, complex magnetic fields upon human experiences. Our approach has emphasized the isolation of the neuroelectrical patterns and regions of the brain that generate NDEs rather than the attempts to refute or support their validity. Obviously, the two issues are not necessarily mutually exclusive. Our testing procedure will be briefly described below.

A normal individual is seated in a comfortable chair within a darkened, acoustic chamber. The individual's eyes are covered with opaque goggles. Complex sequences of weak

Table 5.1 General categories of reported experience before, during and after the termination of out-of-body-experiences (derived from 50 cases) (Persinger, 1974).

1. Antecedent condition
   (a) Normal sleep, 14%
   (b) Anaesthesia, 18%
   (c) Excessive fatigue, 24%
   (d) Crisis/near-death, 34%
   (e) Nothing unusual, 10%
2. Initial sensations
   (a) Tingling or strange feeling, 10%
   (b) "Nothingness", 8%
   (c) "Spinning", moving through space, 16%
   (d) "Heard sweet music or 'name'", 8%
   (e) Paralysis or pain, 12%
   (f) Thinking about OOBE, 8%
3. Detachment
   (a) Saw body while "consciousness looked down", 44%
   (b) No detection of "body", 46%
4. Experience of finding self in "another place", 66%
   (same place but independent of body, 33%)
   (a) Another place, but earth, 33%
   (b) Another place, but not earth, 67%
5. If not earth
   (a) A dark abyss or valley, 27%
   (b) A bright, luminous light appearing at distance of blackness and approaching experient, 45%
   (c) Colourful meadows landscape, 27%
6. A sensed presence, 80%
   (a) Voices, identified as angel, god or dead person saying "go back", 73%
   (b) Sight of dead people (related to experient), 24%
7. Before the end of the experience
   (a) Voice says "go back", 36%
   (b) No obvious indicator, 52%
   (c) Fear, 8%
   (d) A coercive force, 4%

magnetic fields are applied through the brain by solenoids within containers that are attached by velcro along the scalp or by clusters of solenoids that were embedded within a helmet which is worn by the participant. The rationale for this procedure is that the sudden removal of visual and auditory input allowed the estimated several millions of neurons, normally involved with this routine surveillance of the environment, to be recruited into the weak neuronal ensembles induced by the complex magnetic fields. Consequently, the weak experiential correlates of these experimentally induced neuropatterns could be amplified into "conscious" awareness and hence could be reported by the experient (Persinger, Richards and Koren, 1994; Persinger and Richards, 1995). The intensity of the magnetic fields are in the order of 0.1 to 1 microTesla (1–10 milligauss). Our assumption was that complexity and information within the computer-generated patterns were more biologically relevant than their magnitude, given the amplifying capacity (stochastic resonance) of endogenous neural networks. Consequently, the incremental voltages, digitally to analog converted, can involve between 200 and 10 000 sequences (or

lines) of code whose graphic representation could range from the simplistic sign wave to the complex equivalent of the spoken word.

We have assumed, as have Edelman (1989), Crick and Koch (1990) and Eccles (1992), that the phenomena of consciousness and self-awareness exist within a narrow band of weak neuroelectrical interactions within fields generated by the entire cerebral cortex. The frequency band for this "binding" or "cohesion" factor is approximately 40 Hz as measured by contemporary electroencephalographic techniques. If the experience of waking consciousness and "dream states" is recreated every 20–25 ms as reported by Llinas and Ribary (1993), then subtle complex magnetic fields that induce interference patterns in the cerebral field may be as effective in producing NDEs as more traditional stimuli. Consequently, the isolation and understanding of (1) the precise duration of the pixels that generate the applied elecromagnetic fields, (2) the specific timing of those pixel series and (3) the time between packages of these pixels that affect the "binding factor" could also allow the reproduction of altered states, including the NDE.

Table 5.2 shows the percentages of volunteers who have reported the classic types of experiences associated with these experiments. These items were contained in a "debriefing questionnaire" that was completed by the participant at the end of the experiment (which takes between 15 and 30 min). This was only one procedure by which the experiences were monitored. Because this method of monitoring experience was limited by potential amnesia and by the bias of reconstructing the experiences due to the syntax of the items, other methods of measurements have also been employed in our experiments. All subjects were told that the experiments were involved with relaxation and that they may or may not have involved exposure to weak magnetic fields whose intensities were less than that associated with a hair-dryer. Experiments were usually conducted according to a double-blind

Table 5.2 Proportions of 91 volunteers (tested in 1995) reporting specific experiences (not graded for frequency) during application of complex weak magnetic fields across the temporoparietal lobes with co-stimulation of the limbic regions

Debriefing questionnaire item	Percentage reporting yes
1. I felt dizzy or odd	73
2. I felt the presence of someone	24
3. There were tingling sensations	70
4. There were visual sensations	55
5. There were pleasant vibrations moving through my body	54
6. I felt as if I left my body	26
7. I heard an inner voice calling my name	3
8. I experienced anger	18
9. I experienced sadness	43
10. The experiences did not come from my mind	15
11. I heard a ticking sound	31
12. There were odd smells	10
13. I experienced terror or fear	35
14. There were odd tastes in my mouth	11
15. I felt as if I were somewhere else	41
16. I experienced thoughts from childhood	51
17. The same idea kept occurring	69
18. I felt as if I were spinning around	27
19. There were images from a dream I've had	31

procedure: neither the subject nor the experimenter (usually a graduate student or undergraduate thesis student) were familiar with the primary hypothesis being tested.

As can be seen from Table 5.2, which contains the results of several different experiments, the experiences of being detached from the body and leaving the body as well as the sense of presence were reported by about 25% of the participants in this series. The hemisphere over which the magnetic fields were applied (resulting in anistropic resonance within groups of neurons within either the left or right cerebrum) strongly affected the occurrences of specific types of experiences. Application of complex, pulsed magnetic fields over the right hemisphere or both hemispheres evoked a "sensed presence" in about 70% of all participants, while application of the same field patterns over the left hemisphere rarely evoked these experiences. When the sensed presence occurred, both the feeling and the correlative experiences were reported to have profound personal and emotional significance (even in a laboratory context).

Factor analyses of the responses for the items (for each item possible scores were: 0 = never, 1 = at least once, 2 = several times), based upon about 200 participants, revealed shared sources of variance that were influenced by the person's "temporal lobe sensitivity", as inferred from their scores on the complex partial epileptic-like sign indicator (Persinger and Makarec, 1993) and by gender. Whereas a factor that was positively loaded by experiences of dizziness, sensed presence, OOBE and "being somewhere else" was characteristic of right-handed women, right-handed men displayed greater scores for a factor loaded positively by reports of a sensed presence, the conviction that the experience was ego-alien (not from one's own mind) and the feeling of being somewhere else.

Experiments in which participants were requested to speak during the exposure allow narrative text to be analysed. However, the act of introspection during the field exposures shifts the regions of cerebral activity that potentially interact with the applied magnetic fields. This procedure has both advantages and disadvantages. One example of the type of free narrative detail that was reported by a subject who received stimulation by a 1 microTesla pulsed wave containing 200 sequential points whose pixel durations were 3ms, and which was presented every 3000 ms for 20 min, is shown in Table 5.3.

Table 5.3 Specific immediately reported experiences of a male experient who received stimulation bilaterally over the temporal–parietal–occipital interface from 20 min.

Time	Experience
0:30	There is a tingling in my head
0.56	I feel like I am pulsing . . . strange pumps
1:00	I am being pulled down from my legs
2.38	There are vague images . . . water in a river . . . horses . . . just saw an image of a snake
9:00	I see a ladder . . . a rope . . . it's black and I'm going into it
9:20	The lights are spinning . . . light is splitting . . . dark centre with bright edges
9:25	I am flying . . .
9:30	Something is going up like a vortex, an inverted tornado
9:40	I'm spinning rapidly
10:00	I see a light . . . a flashlight at the end shining at me
10:10	I feel something to my left . . . there is something there . . . a shadow of someone to my right
10:30	I see trees . . . a cotton grove . . . see green . . .
10:55	Something is spinning around me . . . the word "lateral" keeps occurring . . . there's a hand on a lever moving back and forth
11:30	I see cartoons . . . like Walt Disney characters

The themes that evolved over the exposure time were dizziness, a pulling force, variations of a tunnel-like perception, spinning and flying, a light at the end of this tunnel (attributed to a flashlight), a peaceful forest scene, an intrusive word "lateral", and humanoid equivalents (cartoons). Because the experiences were generated within an experimental context and were not preceded by a crisis or potential death, the details would be expected to be, and were, more mundane.

Table 5.4 contains the narrative (explicatives and non-verbal sounds, e.g. "uhs", deleted) of a woman who received stimulation over the right caudal hemisphere by a different pulsed field generated by 500 pixels (1 ms in duration) presented every 330 ms. The dizziness and detachment experiences were reported first. The predicted and frequent reports of a feeling of fear (associated with right-hemispheric stimulation) and a bright light then occurred. The dream-like experiences, often attributed in this context to childhood memories, followed. Stimulation of the right hemisphere, as shown in this case, was primarily associated with a left-lateralized feeling of a presence and somatic (twitching, touch) sensation. A subjective experience of an "interactive" relationship with the presence, e.g. "it moves when I think about it", often encourages the explanation that the phenomenon responded to the "thought". Finally, the experience of "someone saying something" and being with a group of friends, not present, was reported.

Table 5.4 Serial narrative of a woman who received right-hemispheric stimulation for 15 min. Each experience occurred for approximately 20 s to 1 min.

1.	I feel dizzy . . . like spinning
2.	My foot . . . feet aren't right . . . they feel small . . . not here
3.	I feel I'm not here . . . not in my body . . . I can't feel it.
4.	There are lights . . . greenish . . . purple . . . I see a tube in front of me . . . darkish . . . soft tube
5.	I'm kind of afraid . . . moving head forward into it. I feel I'm looking straight ahead and not down at the floor.
6.	I see my mother . . . she's [unintelligible]
7.	There's a bright white light everywhere . . . I'm floating around in this big white light . . . it seems to swallow me
8.	Images . . . lots of images . . . like a dream . . . this is weird
9.	I feel someone . . . when I say something he goes away . . . I'm warm . . . my left side is twitching
10.	It moves from left to right when I think about it . . . I feel close to him . . .
11.	Somebody's saying something to me . . . I'm not here . . . with my friends . . . I see them
12.	I'm relaxed . . . there a triangle . . . that stupid triangle keeps turning

Taken together, the results of the research by the Laurentian University Neuroscience Research Group (Cook and Persinger, 1997; Healey, Persinger and Koren, 1996; Persinger, 1996; Persinger, Richards and Koren, 1994; Tiller and Persinger, 1994) have indicated that all major themes associated with natural NDEs have occurred within our experimental setting (Persinger, 1993b). The specific sequence of the temporal evolution of these experiences within the experimental setting has been less integrated than natural NDEs and the details are more context (laboratory) dependent. Even the most subtle innuendo or expectancy can affect the details (hence the employment of double-blind procedures). However, both our ethics and methods inhibit us from exposing the volunteers to the type of sequence that would stimulate the vascular correlates of the limits that approach physiological termination.

CONCLUSION

The themes of NDEs are alike historically and cross-culturally. These "common phenomenological themes" are extremely similar to the known patterns of experiences correlated with enhanced, transient electrical activity within the regions of the brain supplied or influenced by the posterior cerebral artery. Although transient vascular insufficiency would be a central source of stimulation, other stimuli that affect the networks associated with these structures and simulate the neuroelectromagnetic patterns that are generated during these more extreme physiological states, would also activate the continuum of NDE. The details of the experiences would be influenced by the person's cultural beliefs and the individual reinforcement history.

There is not a single component of the themes within the NDEs that has not been evoked by surgical stimulation of the temporal lobes or mesiobsal structures (the hippocampus–amygdala) of complex partial epileptic patients or by application of weak complex magnetic fields through the cerebral hemispheres of normal, non-dying individuals. Because ethical restrictions prevent the application of forces sufficient to exactly reproduce the sequence of metabolic challenge that occurs during actual near-death events, the experimental simulations involve more limited sequences whose details are affected by the context. For an experienced near-death event to be remembered requires that the stimulus (insult) does not evoke electrical disruption within the hippocampal formation during the consolidation of the experience.

The mind is likely to be the neurocognitive equivalent of the prescientific concept of the "substance" phlogiston which emerged as an explanation for "why things burn". With the growth of the measurements and concepts of modern chemistry, the quantitative data could be analysed externally to the singular perspective of egocentric perception. The idea of phlogiston was no longer required. Paper still burned but the mechanism and process were neither mysterious nor implicitly non-physical. People still experience the phenomenon of an entity labelled "the mind", but it, like phlogiston, is no longer required as the only explanation for experiences.

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MIND MYTHS

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